THIS CONDITION IS TRUE IF EITHER $i > n$, OR FOUND = TRUE, OR BOTH.

A VARIATION ON THE <u>SEQUENTIAL SEARCH</u> ALGORITHM LOOKS FOR A GIVEN NUMBER (KEY) FROM A LIST $a_1, \ldots, a_n$ OF NUMBERS. IF A MATCH IS FOUND, THE INDEX i FOR WHICH $a_i = KEY$ IS RETURNED, OTHERWISE 0 IS RETURNED.

<u>GIVEN</u>: $n \geq 1$, $a_1, \ldots, a_n$, KEY
<u>FIND</u>: THE FIRST INDEX i SUCH THAT $a_i = KEY$. IF NO MATCH, RETURN 0.

1.) SET i TO 1
2.) SET FOUND TO FALSE
3.) REPEAT UNTIL $i > n$ OR FOUND
4.) IF $a_i = KEY$
5.) SET FOUND TO TRUE
6.) ELSE
7.) SET i TO $i + 1$
8.) END OF LOOP
9.) IF NOT FOUND
10.) SET i TO 0
11.) PRINT i
12.) STOP

<u>EX</u>. TRACE WITH (3, -1, 2, 5, 12), $n = 5$, KEY = 2

HOW CAN WE MODIFY EITHER VERSION TO FIND THE 2^{ND} (OR i^{TH}) OCCURANCE OF KEY?
TO FIND EVERY OCCURANCE?

ANOTHER COMMON PROBLEM IS TO FIND THE LARGEST ELEMENT IN A LIST OF NUMBERS.

FIND-LARGEST ALGORITHM

GIVEN: $n \geq 2$, AND n DISTINCT NUMBERS $a_1, \ldots, a_n$
FIND: THE LARGEST VALUE IN THE LIST AND ITS LOCATION (i.e. THE INDEX WHERE IT OCCURS.)

1.) SET MAX TO a_1
2.) SET LOCATION TO 1
3.) SET i TO 2
4.) REPEAT UNTIL $i > n$
5.) IF $a_i >$ MAX
6.) SET MAX TO a_i
7.) SET LOCATION TO i
8.) SET i TO $i+1$
9.) END LOOP
10.) PRINT MAX
11.) PRINT LOCATION
12.) STOP

EX. BRIEFLY TRACE EXECUTION ON
(2, 1, -7, 5, 3, 11, 0)

HOW DOES THIS ALGORITHM BEHAVE WHEN GIVEN A LIST OF NON DISTINCT NUMBERS?
e.g. (1, 3, 0, 10, 3, 5, 10)

HOW CAN THE ALGORITHM BE MODIFIED TO RETURN THE NUMBER OF TIMES THE MAXIMUM OCCURS? (HINT: COMBINE WITH SEQUENTIAL SEARCH.)

HOW CAN WE MODIFY IT TO FIND THE MINIMUM?

ANOTHER CLASSICAL PROBLEM IN COMPUTER SCIENCE IS <u>PATTERN MATCHING</u>. THERE ARE MANY VERSIONS OF THIS PROBLEM, DEALING WITH PATTERNS IN GRAPHICS, SOUND, PICTURES, AND OTHER TYPES OF DATA.

WE WILL CONSIDER A SIMPLE FORM OF THIS PROBLEM: FINDING PATTERNS IN TEXT DATA.

MORE PRECISELY, GIVEN n CHARACTERS OF TEXT

$$T_1 \; T_2 \; \ldots \; T_n$$

AND GIVEN A PATTERN OF m CHARACTERS, WHERE $m \leq n$

$$P_1 \; P_2 \; \ldots \; P_m$$

FIND EVERY OCCURANCE OF THE PATTERN WITHIN THE TEXT, I.E. FIND EACH INDEX POSITION IN THE TEXT AT WHICH THE PATTERN BEGINS.

EX $n = 18$, $m = 2$
TEXT: TO_BE_OR_NOT_TO_BE
PATTERN: BE
ANSWER: 4, 17

EX
TEXT: xxxaaaaaaxx
PATTERN: aaa
ANSWER: 4, 5, 6

NOTICE THAT IF $m=1$, i.e. THE PATTERN HAS JUST ONE CHARACTER, THEN THIS PROBLEM IS NOT ESSENTIALLY DIFFERENT FROM SEARCHING A LIST. WE MAY EXPECT THAT OUR ALGORITHM WILL SHOW SOME SIMILARITY TO SEQUENTIAL SEARCH.

EX. $n=7$, $m=3$

$T_① T_2 T_3 T_4 T_5 T_6 T_7$ $\quad i=1$
$P_1 P_2 P_3$

SLIDE OVER → $T_1 T_② T_3 T_4 T_5 T_6 T_7$ $\quad i=2$
$P_1 P_2 P_3$

→ $T_1 T_2 T_③ T_4 T_5 T_6 T_7$ $\quad i=3$
$P_1 P_2 P_3$

→ $T_1 T_2 T_3 T_④ T_5 T_6 T_7$ $\quad i=4$
$P_1 P_2 P_3$

→ $T_1 T_2 T_3 T_4 T_⑤ T_6 T_7$ $\quad i=5$
$P_1 P_2 P_3$

POSSIBLE ANSWERS ARE INDICIES i RANGING FROM 1 TO $n-m+1$

PATTERN MATCHING ALGORITHM

GIVEN: $n \geq 1$, $m \geq 1$, $m \leq n$

$T_1 T_2 \cdots T_n$, $P_1 P_2 \cdots P_m$

FIND: ALL INDICIES i SUCH THAT $P_1 \cdots P_m$ MATCHES $T_i \cdots T_{i+m-1}$.

```
1.) SET i TO 1
2.) REPEAT UNTIL  i > n-m+1
3.)     SET j TO 1
4.)     SET MATCH TO TRUE
5.)     REPEAT UNTIL j>m OR MATCH = FALSE
6.)         IF P_j ≠ T_{i+j-1}
7.)             SET MATCH TO FALSE
8.)         ELSE
9.)             SET j TO j+1
10.)    END loop
11.)    IF  MATCH = TRUE
12.)        PRINT 'MATCH FOUND AT POSITION:'
13.)        PRINT i
14.)    SET i TO i+1
15.) END loop
16.) STOP
```

Ex.

HAND THE BAND TO ANDY AND I

SEARCH FOR : AND , _AND , AND_ , _AND_

HW 2 DUE { 01 - WED 10/~~6~~4
02 - THR 10/~~7~~5

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1, 6, 9, 12, 13, 15, 17, 18.